

Welcome to the UT Austin Fall 2020 miniSO invitational!
We're so glad you're here!!

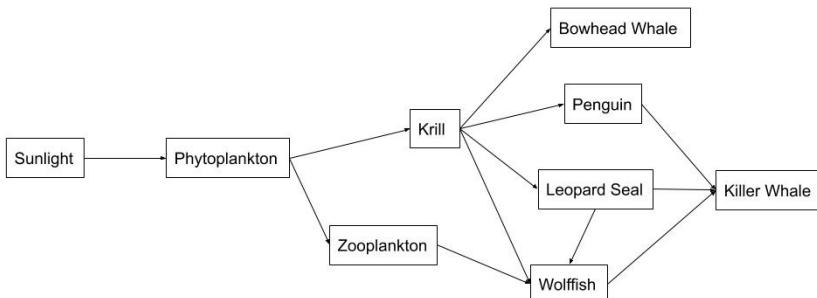
As this is the very first invitational of the year for most of you, we have included a mix of easy, mediocre, and difficult questions. Good luck and enjoy!

Exam Authors:

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ATX SCIENCE OLYMPIAD

- The rules for this event have been adapted for our virtual tournament and follow the **2020-2021 Regional Rules**.
- For fill-in-the-blank questions, the capitalization of the answers (e.g. Answer vs. answer) will **NOT** be considered (i.e. both answers will be accepted). However, incorrect spelling and unnecessary spaces before/after the answers will lead to an **incorrect** answer. Keep this in mind!
- For multiple-choice questions with multiple answers, it's ALL or NOTHING - there's no partial credit!
- The maximum number of obtainable points on this exam is **210**.
- If you have any questions or concerns regarding this exam, feel free to contact us through the following emails: shrayenpatel@utexas.edu and wiliampatrone@ufl.edu
- Questions 1-18, 43, and 63-68 were written by William. Questions 19-42, 44-62, and 69 were written by Shraven. **Please email your questions to the correct author!**



Questions 1-2 deal with the food web above

- 1. (2.00 pts)** Which organism(s), if any, are considered tertiary consumers?

(Mark **ALL** correct answers)

- A) Wolffish
 B) Leopard Seal
 C) Killer Whale
 D) Penguin
 E) Sunlight
 F) Bowhead Whale

- 2. (2.00 pts)**

If a phytoplankton receives 76,000,000 J of energy from the sun, how much energy, in **kJ**, would a wolffish receive? Please leave kJ out of your answer choice, as it will not auto-grade correctly!!

3. (20.00 pts)

Identify the 5 steps of algal bloom formation. Explain what occurs during each step and how each step can be impacted by changing environmental or ecologic conditions.

Expected Answer: An explanation without the correct naming for the step will grant full points. 1) Cyst/hypnozygote formation: Cysts begin to form in the body of water, triggered by environmental stressors like nutrient limitation 2) Cysts settlement: Cysts come to the surface, where blooms begin to form. Can be delayed by adverse conditions 3) Excystment: process of escaping cysts. Only occurs in favorable conditions with high nitrogen 4) Population Multiplication: population growth, both photoautotrophically and mixotrophically. Competition with other species 5) Biomass accumulation: Movement of cells through the water column; hydrodynamic processes move water through the water

4. (2.00 pts)

The critical density of algae is the number of harmful algae in the water, that will cause an adverse environmental impact. What is the critical density, in **cells/dekaliter**, that will cause fish kills. There is a range, so your answer must fall within that range.

Expected Answer: Any number in the range of 10,000-25,000 cells



Use this map to answer question 5

5. (3.00 pts)

This map shows common occurrences of *Karenia breve*, a harmful algae. Which type of toxin is produced by this organism and what is the name of the human health effect that goes along with it

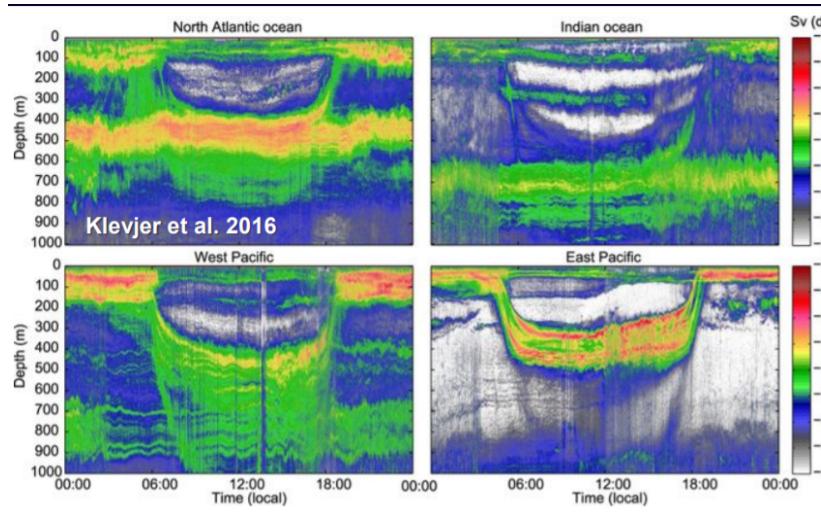
- A) Karenitoxin; Paralytic Shellfish Poisoning
- B) Karenitoxin, Amnesic Shellfish Poisoning
- C) Neuratoxin: Neurotoxic Shellfish Poisoning
- D) Neuratoxin, Amnesic Shellfish Poisoning
- E) Brevetoxin, Neurotoxic Shellfish Poisoning
- F) Brevetoxin, Diarrhetic Shellfish Poisoning

6. (2.00 pts)

Ciguatoxin is a harmful substance secreted by algae in blooms, causing Ciguatera Fish Poisoning. Some organisms are susceptible to the toxin in both the Pacific and Atlantic, while others only bioaccumulate in one region. Which fish species, if any, accumulate ciguatoxin in both the Atlantic and Pacific?

(Mark ALL correct answers)

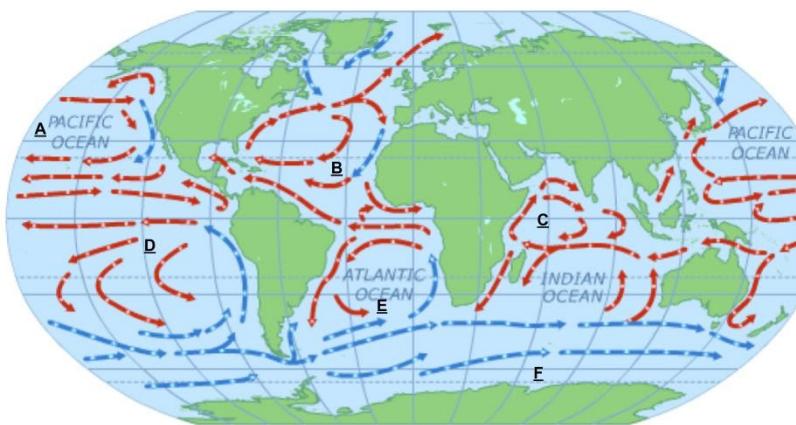
- A) Snapper
- B) Dolphin (also called mahi mahi)
- C) Barramundi Cod
- D) Grouper
- E) Barracuda
- F) Amberjack



Use this figure to answer question 7

7. (3.00 pts) What ecological phenomenon is depicted in the image above

- A) Open Ocean Bloom Scattering
- B) Physiological Thermoregulation
- C) Diurnal Migration/Mesopelagic Scattering Layer
- D) Lamnid Shark Migrations in the Water Column

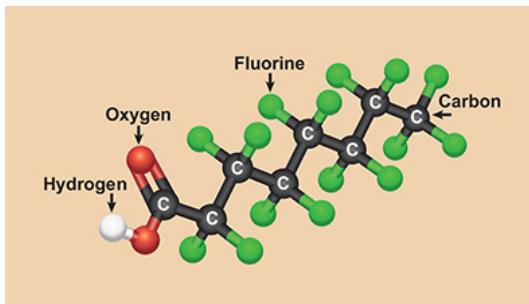


Use this image to answer question 8

8. (3.00 pts) Which location does NOT have one of the world's five garbage patches, using the map above

- A) A
- B) B
- C) C
- D) D

- E) E
 F) F



Use this image to answer question 9

9. (3.00 pts) Select all compounds that would be categorized as PFAS chemicals

(Mark ALL correct answers)

- A) Perfluorobutanesulfonic acid
- B) 6:2 Fluorotelomer acrylate
- C) Ammonium perfluorononanesulfonate
- D) Trifluoroacetate

- E) 1,3-Bis(trifluoromethyl)-5-bromo-benzene
- F) Perfluoro-4-(perfluoroethyl)cyclohexylsulfonate

10. (3.00 pts) Mangroves are considered a keystone species in many estuarine ecosystems. Which of the following are ecosystem services provided by mangrove forests?

(Mark ALL correct answers)

- A) Decrease turbidity
- B) Used as a nursery for young fish
- C) Increase coastline stability
- D) Remove toxins from the water
- E) Raise dissolved oxygen levels in the water
- F) Reduce creep from storm surges

11. (6.00 pts) What is the name of the algae associated with corals? Also, explain the obligate nature of the algae and corals.

Expected Answer: zooxanthellae (+2) Corals use zooxanthellae to produce food via photosynthesis (+2) Zooxanthellae use corals for protection from predation (+2)

12. (3.00 pts) What step in potable water treatment is most susceptible to algal blooms?

- A) Sedimentation
- B) Pre-treatment
- C) Particle Aggregation
- D) Filtration
- E) Disinfection
- F) Nutrient Collusion

13. (4.00 pts) What are the two most likely reasons a septic tank disposal system may fail?

Expected Answer: The tank is not emptied (+2), the soil drainage is poor (+2)

14. (2.00 pts) What does the acronym 'FOG' mean in wastewater treatment?

Fats	Oil	Grease
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15. (8.00 pts) What are the four reasons to use microscopy in wastewater treatment?

Expected Answer: Monitor floc formation (+2) Study non-bacteria in the water (+2) Study blocking in bacterial species (+2) Evaluate bulk water (+2)

16. (2.00 pts) In what step are filamentous bacteria the most influential in the wastewater treatment process?

Flocculation

17. (3.00 pts) Select each term that is synonymous with the word 'estuary'

(Mark **ALL** correct answers)

- A) Afterbay
- B) Aggrade
- C) Bay
- D) Firth
- E) Lagoon
- F) Riprap

18. (2.00 pts) The inflow of lower-salinity water into an estuary that pushes more saline water out is known as _____.

Expected Answer: anti-estuarine circulation

Use the following images for the next FIVE questions (19-23):



19. (1.00 pts) What is the common name of organism A (enter exactly as printed in the rules manual, with NO spaces in between words if applicable)?

Butterflyfish

20. (1.00 pts) What is the common name of organism B (enter exactly as printed in the rules manual, with NO spaces in between words if applicable)?

Parrotfish

21. (4.00 pts) Which of the following statements regarding organism A are **TRUE**?

(Mark ALL correct answers)

- A) There are over 100 unique species of this organism
- B) This organism is only located in the Indo-Pacific region
- C) Upon reaching adulthood, this organism grows up to 9 inches long on average
- D) At night, this organism's vibrant colors fade, allowing it to blend in with its surroundings
- E) This organism currently has an endangered conservation status
- F) This organism is diurnal, which means it rests during the day and feeds during the night

22. (4.00 pts) Which of the following statements regarding organism B are **FALSE**?

(Mark ALL correct answers)

- A) This organism spends most of its day consuming algae from coral reefs
- B) This organism has teeth inside its throat
- C) This organism typically grows to a length of greater than 2 feet
- D) There are more than 125 unique species of this organism
- E) This organism is not vital to the health of coral reefs
- F) The teeth of this organism are structured in a way that provides a blueprint for creating other ultra-durable synthetic materials

23. (3.00 pts)

Both organisms A and B reside in coral reef habitats. Which organism is considered more vital to the growth and stability of coral reefs? Describe why. Then, list what this organism typically excretes from its body.

Expected Answer: Organism B/Parrotfish (1) Clean reef of algae by removing/eating algae that compete w/ coral (1) Poop out sand (1)

Use the following image for the next THREE questions (24-26):



C:

24. (1.00 pts) What is the common name of organism C?

- A) Hard Coral
- B) Crown of Thorns Starfish
- C) Pencil Urchin
- D) Sea Cucumber
- E) Long-spined Black Sea Urchins
- F) None of the above

25. (2.00 pts) A single female of organism C typically produces more than how many million eggs?

- A) 400
- B) 300
- C) 200
- D) 100

26. (2.00 pts) According to recent studies, approximately how many years of development do members of organism C require before preying on coral?

Hint: a single number (no decimals), one digit long

6

Use the following image for the next FIVE questions (27-31):



27. (1.00 pts) What is the common name of organism D (enter exactly as printed in the rules manual, with NO spaces in between words if applicable)?

bandedcoralshrimp

28. (2.00 pts) What's so special about the claws of organism D?

Expected Answer: They can automize (break off by natural means) when the individual feels threatened

29. (2.00 pts) Organism D is polygamous.

True False

30. (2.00 pts) Organism D employs a _____ mechanism to show nearby fish that it is ready and eager to clean!

dancing

31. (2.00 pts)

BLANK 1: Do members of the species of organism D portray sexual dimorphism? ("yes" or "no")

BLANK 2: If "yes" for the previous question, which gender of this species is typically larger? ("females" or "males") If "no" for the previous question, please enter "N/A" for the second blank!

yes

females

Use the following image for the next FOUR questions (32-35):

E:



32. (1.00 pts) What is the common name of organism E (enter exactly as printed in the rules manual, with NO spaces in between words if applicable)?

Gorgonia

33. (2.00 pts) What are the possible colors of organism E?

(Mark ALL correct answers)

- A) Purple
- B) Yellow
- C) Brown
- D) Green
- E) Red
- F) Orange

34. (3.00 pts) Describe the development of organism E.

Expected Answer: Once a planulae polyp is settled on a hard surface, the young polyp creates a horizontal layer of aragonite called the basal disk. (1) As the polyp grows upward, the base's margin also turns upward, forming a cup called the epitheca, which contains daily growth bands. (1) These and other structures called septa form the skeletal boundaries found at the bottom of the coral polyps, which are left behind as a result of the upward growth of the polyp. (1)

35. (2.00 pts) Which of the previous organisms (A, B, C, or D) has species which are known to consume organism E?

- A) A
- B) B
- C) C
- D) D

Use the following image for the next FOUR questions (36-39):



36. (1.00 pts) What is the common name of organism F (enter exactly as printed in the rules manual, with NO spaces in between words if applicable)?

seacucumber

37. (2.00 pts) The larvae of organism F are _____

Expected Answer: plankton OR planktonic (full credit for either)

38. (2.00 pts) What type(s) of reproduction does organism F exhibit?

- A) Sexual
- B) Asexual
- C) Both of the above
- D) Neither of the above

39. (2.00 pts) What defense mechanism(s) does organism F use to protect itself from predators?

Expected Answer: If you pick up or bother a sea cucumber, it will squirt water from its rear hole, and it may even eject its innards

40. (3.00 pts) Which organisms (A-F) are threatened by overfishing?

(Mark ALL correct answers)

- A) A
- B) B
- C) C
- D) D
- E) E
- F) F

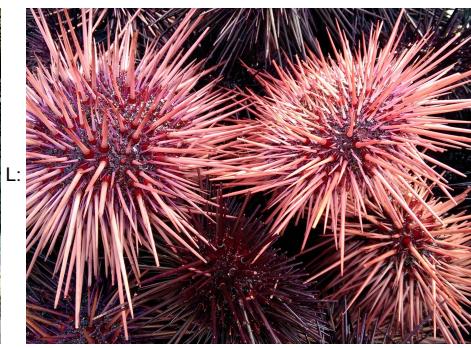
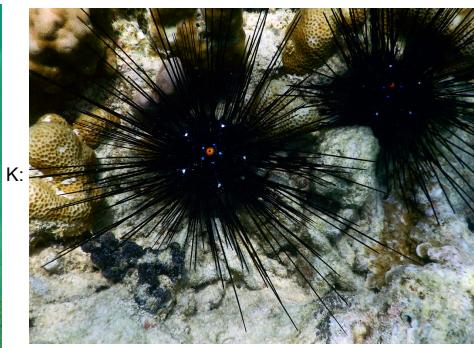
Use the following images for the next question (41):



41. (4.00 pts) What is the common name of organisms G, H, and I?

Expected Answer: G: grouper (1) H: grouper (1) I: nassau grouper (1) 4th point automatically awarded as a bonus if they get all three organism IDs correct!

Use the following images for the next question (42):



42. (1.00 pts) Of organisms J, K, and L, which are long-spined black sea urchins?

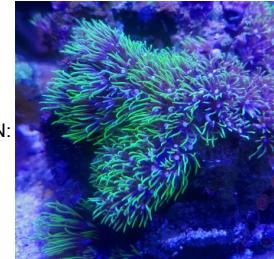
Expected Answer: J, K (all or nothing)

43. (4.00 pts) There are a handful of organisms in the rules that have 'spp.' in their scientific name, for example, *Chaetodon spp.*

What does 'spp.' mean in a scientific name? Why is it important to use spp. in scientific analysis?

Expected Answer: Spp. means several species (+2) It is useful because it means you are describing an entire genus, especially when an article is talking about the characteristics of an individual species within the genus. (+2)

Use the following images for the next question (44):



44. (15.00 pts)

Of organisms M-X, which are from this event's 2020-2021 rules?

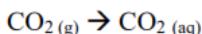
For **EACH** organism from the 2020-2021 Water Quality species list, identify the organism and its common name (example format: " M - Lobster ")

You may be asking yourself "why would he do this to us?!" and the answer is: to ensure you're actually able to distinguish between organisms and aren't just guessing from the given list!! Nevertheless, this is the last question of Section 2, and I had to throw a curveball at you!

Expected Answer: * -1 point for each INCORRECT answer; 0 points for a blank answer * M - Hard Coral (2) O - Sweetlips (2) P - Sweetlips (2) Q - Sweetlips (2) U - Moray Eel (2) V - Moray Eel (2) If they got all of the above correct, the team is awarded an automatic +3 for a full score of 15 points for this question!

Use the following scenario for the next EIGHT questions (45-52):

It's a bright morning and we have a group of 15 jetsetters (no, it's not an actual organism, don't panic) having a civil discussion in their 35 degree Celsius extravagant ocean residence. We will call them jetsetter 1 through jetsetter 15. Jetsetter 7 (a male) and jetsetter 8 (a female) are in disagreement with the rest of the group on several topics! First, those two believe that corals require low oxygen levels and are excluded by high inputs of nutrients, while the rest of the jetsetters believe that corals require high oxygen levels yet are still excluded by high inputs of nutrients (45). Second, those two believe that the coral calcification rate is higher at lower concentrations of carbonate ion, while the rest of the jetsetters believe that the coral calcification rate is higher at higher concentrations of carbonate ion (46). Third, those two believe that the reactions associated with the process of dissolved inorganic carbon are accurately represented by the following set of equations, while the rest of the jetsetters believe that there's a missing step (47).



Since jetsetters 7 and 8 can't come to an agreement with the rest of the group, they decide to abandon the other jetsetters and embark on their own journey, rather than serving as a hindrance to the rest of the group's research. They're so confident that this is the right move for them, they take their relationship even further by clearing the team and blocking their old buddies from communicating with them any longer! They proudly (not shamefully) travel southbound towards warmer temperatures, eventually crossing a point-of-no-return to a zone of 15 degree Celsius ocean water in a coastal beach zone (48). Here, the enterococci levels in the saltwater are 111 per 100 mL (49). Jetsetters 7 and 8 want to begin building their own coral reef in their new home (50-52).

45. (2.00 pts) Which group of jetsetters is **CORRECT** about this topic surrounding oxygen levels?

For the group of jetsetters 7 & 8, enter "EH" ; for the rest of the jetsetters, enter "rest"

rest

46. (2.00 pts) Which group of jetsetters is **INCORRECT** about this topic surrounding coral calcification rates?

For the group of jetsetters 7 & 8, enter "EH" ; for the rest of the jetsetters, enter "rest"

EH

47. (10.00 pts) Which group of jetsetters is **CORRECT** about this topic surrounding the equations involved in the process of dissolved inorganic carbon?

For the group of jetsetters 7 & 8, enter "EH" ; for the rest of the jetsetters, enter "rest"

If you selected "rest", please provide any equations you deem to be missing from the process.

No matter whether you selected "EH" or "rest", please list out the balanced net equation for the process as a whole.

Which ion is released in this process, and does it make seawater less acidic or more acidic?

Expected Answer: Correct: rest (2) Missing Equation: $\text{HCO}_3^- \rightarrow \text{CO}_3^{2-} + \text{H}^+$ (3) Balanced Net Equation: $\text{CO}_2\text{(g)} + \text{H}_2\text{O} + \text{CO}_3^{2-} \rightarrow 2\text{HCO}_3^-$ (3) Ion Released: H^+ (1), more acidic (1)

48. (1.00 pts)

Since jetsetters 7 & 8 have migrated to water with a lower temperature, is the dissolved oxygen content of this region "greater" or "less" than the dissolved oxygen content of their previous habitat shared with the other jetsetters?

greater

49. (1.00 pts) Does this enterococci level make this particular patch of seawater safe for humans or not? Please enter "yes" or "no"

no

50. (2.00 pts) The accumulation and deposition of what two specific things are necessary for jetsetters 7 & 8 to create their own coral reef?

Expected Answer: calcium carbonate & limestone (1 pt each)

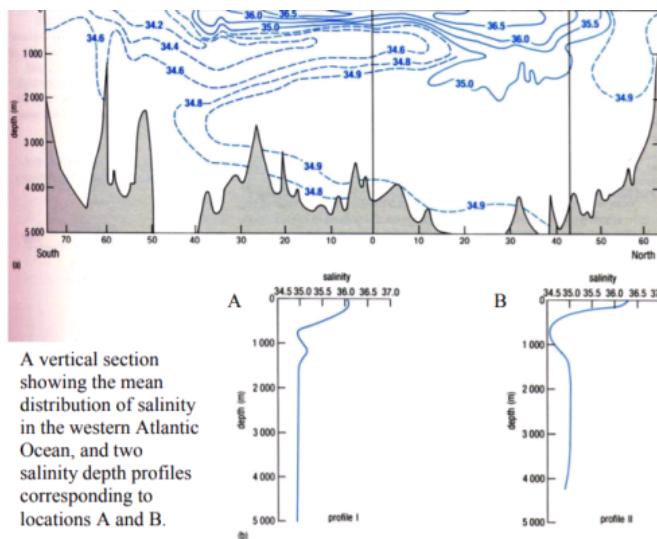
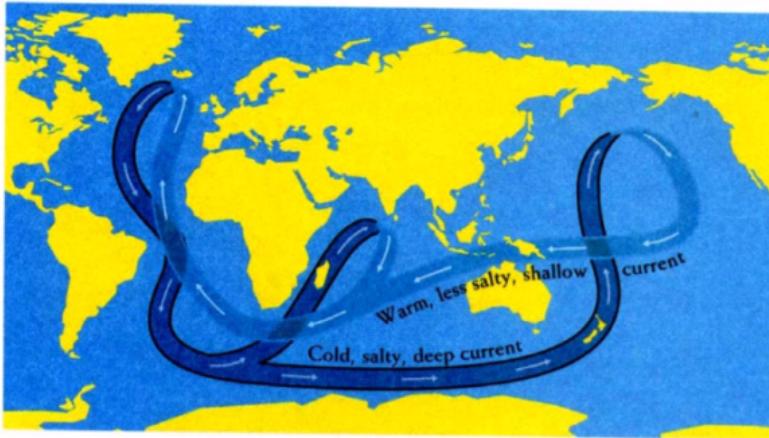
51. (1.00 pts)

Since jetsetters 7 & 8 have migrated to water with a lower temperature, does this region of water have a "higher" or "lower" pH level than that of their previous habitat shared with the other jetsetters?

 higher**52. (3.00 pts)**

Since jetsetters 7 & 8 have migrated to water with a lower temperature, does this region of water have a "higher" or "lower" salinity level than that of their previous habitat shared with the other jetsetters? Explain why.

Expected Answer: higher (1) As temperature decreases, the space between water molecules decreases—also known as density, which therefore increases. As density increases, the number of salts in the water—also known as salinity, increases. (2)

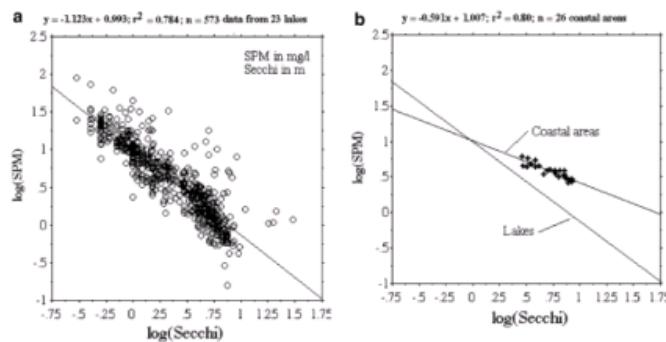
53. (2.00 pts) Which graph ("A" or "B") from the bottom corresponds to the right vertical line on the top diagram?**54. (2.00 pts)** The following diagram is a depiction of what?

Expected Answer: The Ocean Conveyor Belt OR Thermohaline Circulation (full credit for either answer)

55. (4.00 pts)

What does the following diagram tell you about the variability in SPM values between coastal (marine) and lake (freshwater) areas? What element of the diagram communicates this to you? What does a Secchi disk measure?

Fig. 5 a The relationship between Secchi depth (in m) as a standard measure of water clarity and the SPM concentration (mg/l) based on 573 data from 23 lakes covering a wide limnological domain (from highly eutrophic to oligotrophic conditions). **b** The corresponding regression for 26 Baltic coastal areas and a comparison between the two regression lines for lakes and coastal areas. The figure gives the regression line, r^2 coefficient of determination and n number of data



For clarity, the y-axis is "log(SPM)" and the x-axis is "log(Secchi)".

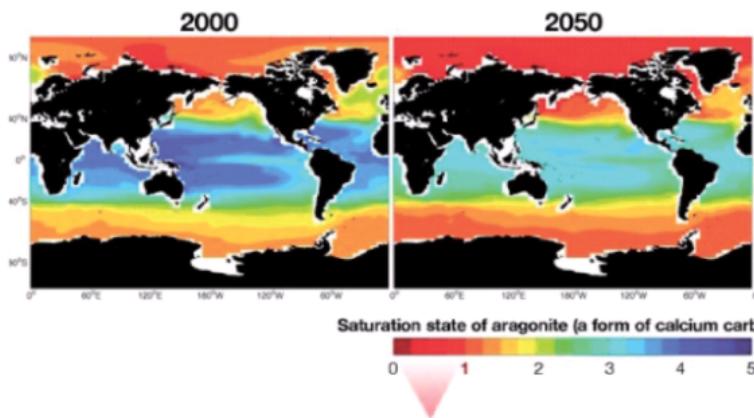
Expected Answer: The variability in SPM values is generally smaller in marine/brackish systems (1) The slope of the regression line is smaller for marine systems than for lakes, which indicates that a given change in Secchi depth would correspond to a smaller change in SPM values for marine systems than for lakes (1) Measures turbidity (1) If the team got all of the above correct, they get the last point as a bonus for a total score of 4 for this question!

56. (5.00 pts) Based on the trend shown in the below diagram, what additional color do you expect to be removed from a depiction of the map in the year 2099?

What can the loss of this color be attributed to?

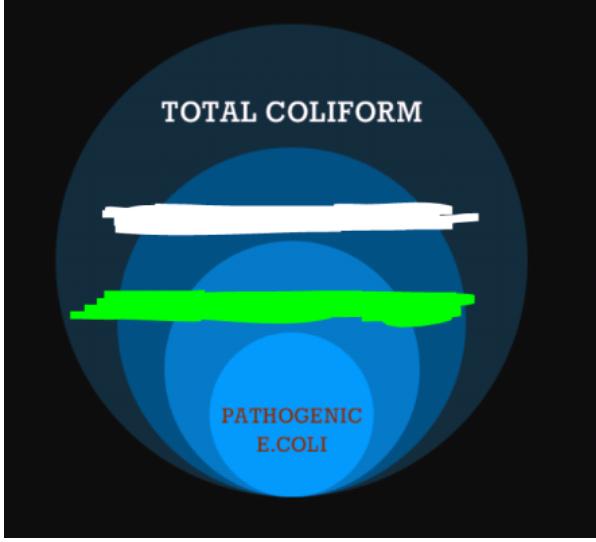
At this point (the year 2099), the aragonite structures would begin to become what? (Hint: look at the diagram to see the saturation levels at this point)

When the aragonite saturation level falls below 1, what happens to exposed shells and skeletons?



Expected Answer: Blue (1) Increasing CO₂ levels OR ocean acidification (1) Stressed (1) Begin dissolving (1) If the team got all of the above correct, they get a bonus point, bringing their total score for this question to 5!

57. (5.00 pts) What label belongs in the white box? What label belongs in the green box?



What property allows the label from the white box to be separated out from the "total coliform"?

Is what is labeled in the white box directly pathogenic?

Expected Answer: White: Fecal Coliform (1) Green: E. Coli (1) The fecal coliform grow at higher temps than total coliform - elevated temperature heat shocks non-fecal bacteria and suppresses their growth; this is how they can be separated out (1) No, not directly pathogenic (1) If the team got all of the above parts correct, they get a bonus point, bringing their total score for this question to 5!

58. (1.00 pts) Which of the following is a type of nonpoint source pollution?

- A) Runoff
- B) Factories
- C) Sewage plants
- D) Power plants

59. (2.00 pts) Acid rain is formed when what **TWO** elements combine with water in the air?

(Mark **ALL** correct answers)

- A) Sulfur dioxide
- B) Nitrogen oxide
- C) Carbon monoxide
- D) Carbon dioxide
- E) Oxygen
- F) Argon

60. (1.00 pts)

The Federal Water Pollution Control Act was amended in 1972 and is now known as the ______. This has made it unlawful to discharge any pollutant from a point source into navigable waters, unless a permit is obtained.

Clean

Water

Act

61. (1.00 pts) As the concentration of nitrates increases in a body of water, the biological oxygen demand of that body of water also increases.

- True
- False

62. (1.00 pts) At sunrise, the level of dissolved oxygen is lowest in a body of water.

63. (8.00 pts)

Roche Harbor, a port city in the state of Washington, is known for producing limestone, also known as calcium carbonate. Suppose a significant amount of limestone is accidentally introduced into Roche Harbor. Using your knowledge of chemistry and equilibrium, describe the effect the introduced limestone will have on pH, and write a balanced chemical equation for the reaction that occurs!

Expected Answer: Adding limestone will cause the area to become less acidic/more alkaline. (+1) The addition of carbonate ions will move equilibrium (+1) toward the side with carbonate ions (+1). In turn, the system will try to restore equilibrium by combining hydrogen ions with the carbonate (+1) to form bicarbonate (+1), decreasing the concentration of hydrogen ions in solution (+1), increasing the pH (+1). $\text{CO}_3^{2-} + \text{H}^+ \rightleftharpoons \text{HCO}_3^-$ (+1)

64. (1.00 pts) Under normal conditions, aragonite saturation does not exceed _____ Ω in a solution of water

Expected Answer: 1

65. (4.00 pts)

Pipes are often color-coded to indicate what substance is traveling through them. Select every option that currently matches the pipe color with the substance that passes through it.

(Mark ALL correct answers)

- A) Dark Blue; Potable Water
- B) Pink; Ozone
- C) Dark Brown; Sludge
- D) Dark Grey; Sewage
- E) Light Grey; Greywater
- F) Red; Chlorine Gas

66. (2.00 pts) Which analyte mentioned in the rules has the biggest impact on the concentration of dissolved oxygen in a sample?

Temperature

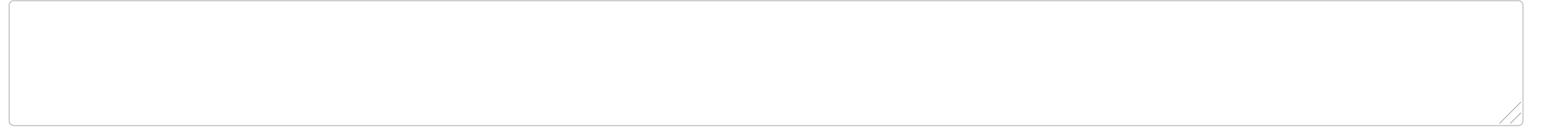
67. (2.00 pts) Which of the following would be classified as salts?

(Mark ALL correct answers)

- A) MgSO_4
- B) LiCl
- C) $\text{C}_6\text{H}_{12}\text{O}_6$
- D) NH_4F
- E) $\text{Ca}(\text{OH})_2$
- F) $\text{Fe}_2(\text{HPO}_4)_3$

68. (4.00 pts) What is the difference between a salinometer and a hydrometer?

Expected Answer: A salinometer measures the concentration of salt in a solution (+2) A hydrometer measures the specific gravity of the water (+2)



69. (1.00 pts) What's your favorite brand of bottled water?

Expected Answer: Any legitimate answer earns 1 point!

Congratulations, you're done! We hope it wasn't too easy for you :)